



**PATENT COOPERATION TREATY**  
**PCT**  
**INTERNATIONAL PRELIMINARY EXAMINATION REPORT**  
(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 031303wo HPJ/ko	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/EP 03/05538	International filing date (day/month/year) 27.05.2003	Priority date (day/month/year) 31.05.2002
International Patent Classification (IPC) or both national classification and IPC B01D39/20, B01D39/20		
Applicant CARBON APPLICATION TECHNOLOGY LTD. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).
- These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:
- I ☒ Basis of the opinion
  - II ☐ Priority
  - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
  - IV ☐ Lack of unity of invention
  - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
  - VI ☐ Certain documents cited
  - VII ☐ Certain defects in the international application
  - VIII ☐ Certain observations on the international application

Date of submission of the demand  22.10.2003	Date of completion of this report  07.04.2004
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer  Hoffmann, A  Telephone No. +49 89 2399-8610 

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP 03/05538

## I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

### Description, Pages

1-16 as originally filed

### Claims, Numbers

1-21 received on 05.03.2004 with letter of 03.03.2004

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. **PCT/EP 03/05538**

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**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability;  
citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Yes: Claims	1-21
	No: Claims	
Inventive step (IS)	Yes: Claims	10-21
	No: Claims	1-9
Industrial applicability (IA)	Yes: Claims	1-21
	No: Claims	

**2. Citations and explanations**

**see separate sheet**

**POINT V:**

1. It is to be mentioned, that the problem to be solved according to the present description is to replace ceramic filters. Thus it does not seem to be appropriate to define the invention of the present application "ceramic filter".
2. D1, in particular page 9, lines 1-7, disclose a method to produce a porous coal-based preform which is afterwards subjected to graphitization. Thus the end product is in principle a network of graphitized carbon.

According to D1, in particular page 9, lines 11-17, a variety of additives and structural reinforcers may be added to the coal-based preforms or products "to enhance specific mechanical properties such as fracture strain, fracture toughness and impact resistance". D1 indicates as structural reinforcers I. a. particles and fibres of ceramic compositions (according to page 10, line 9 in particular ceramic particles) to be incorporated in the coal-based preforms or products. After subsection of such modified coal-based preforms or products to graphitization the final product consists of network of graphitized carbon comprising particles and fibres or fibres alone of ceramic composition depending on the properties to be achieved (knowledge of a skilled person). Furthermore the coal-based preforms or products can additionally be impregnated with , for example, petroleum pitch, epoxy resins or other polymers which were graphitized during subsection to graphitization.

D1 discloses the use of the final product for molten metal, in particular such as aluminium. Since claims 1 and 4 are also directed to molten metal (not limited to molten steel!), the subject matter of claims 1 and 4 does not justify the involvement of an inventive step since the choice taken (ceramic fibres and particles) from a small list of alternatives in D1 lay in the know how of a skilled person. Even if the claims would be directed to molten steel, the skilled person is able to add the structural reinforcers as proposed by D1 in an appropriate way to achieve the respective mechanical stability of the filter end product for molten steel.

It is mentioned that D1 is focussed on the same problem to be solved as the present application (see point 1 above) and proposes about the same solution : see D1, page 12, lines 13-21.

As already mentioned in the present description it is common knowledge to improve mechanical properties of ceramics and composite materials by the addition of fibres and particles (but see also for instance D3, column 4, line 42 to column 6, line 44). Thus it was obvious for the skilled person of D1 to introduce not only the additives disclosed in D1 but also all other known additives, for instance said of D3 mentioned above, to achieve the same aim.

Since the present application is silent about any surprising effect either by the choice of the additives or by the process features, the features of the dependent claims (2, 3, 5-9) cannot justify the involvement of an inventive step (Article 33 (3) PCT).

3. The subject matter of the method claims fulfil the requirements of Articles 33 (2) and (3) PCT, since in general the proposed method is only known for pure ceramic filters (see D4 and D5) but not for graphitized filters as disclosed in D1 and D2.

PCT/EP03/05538  
Carbon Application

HPJ/RC/m  
03 March 2004

Claims:

1. A ceramic filter for molten metal filtration comprising a ceramic powder and fibers bonded by a network of graphitized carbon.
2. The filter of claim 1, wherein the ceramic powder contains or in particular consists of zirconia, silica, alumina, brown fused alumina, magnesia, any type of clay, talcum, mica, silicon, carbide, silicon-nitride and the like or a mixture thereof, or graphite.
3. The filter of claim 1 or 2, wherein the graphitized carbon constitutes up to 15 % by weight, in particular up to 10 % by weight, more specifically 5% by weight.
4. A filter for molten metal filtration comprising fibers bonded by a network of graphitized carbon.
5. The filter of any of claims 1 to 4, wherein the fibers are selected from the group consisting of ceramic fibers, glass fibers, organic fibers, carbon fibers, metal fibers and mixtures thereof.
6. The filter of claim 5, wherein the ceramic fibers are selected from the group of alumina fibers, silica fibers, aluminosilicate fibers and mixtures thereof.
7. The filter of claim 5, wherein the organic fibers are selected from the group of polyester fibers, polyacrylonitrile fibers, polyethylene fibers, polyamide fibers, viscose fibers, aramid fibers, and mixtures thereof.
8. The filter of anyone of claims 1 to 7, characterized in that it contains an amount of 0,1 to 20, in particular 1 to 10 % by weight of said fibers.

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9. The filter of anyone of claims 1 to 6, characterized in that the length of the fibers is in the range of 0.1 mm to 5 mm.

**10. A method to produce filters for molten metal filtration comprising fibers and a bonded network of graphitized carbon, comprising the steps**

- a) impregnating a foam made of thermoplastic material with a slurry containing fibers, a graphitizable carbon bonding precursor and optionally other additives,
- b) drying, optionally followed by one or two coatings of the same slurry in order to increase the mass, followed by final drying,
- c) firing the impregnated foam in non-oxidizing and/or reducing atmosphere at a temperature in the range of from 500 to 1000 °C, in particular from 600 °C to 700 °C,

whereby the carbon bonding precursor is converted at least partially or fully to a bonded network of graphitized carbon and organic fibers undergo a pyrolysis.

**11. A method to produce ceramic filters according to anyone of claims 1 to 3 and 5 to 9, comprising the steps**

- a) impregnating a foam made of thermoplastic material with a slurry containing fibers, ceramic powder and a graphitizable carbon bonding precursor, and optionally other additives,
- b) drying, optionally followed by one or two coatings of the same slurry in order to increase the mass, followed by final drying,
- c) firing the impregnated foam in non-oxidizing and/or reducing atmosphere at a temperature in the range of from 500 to 1000 °C, in particular from 600 °C to 700 °C,

whereby the carbon bonding precursor is converted at least partially or fully to a bonded network of graphitized carbon and organic fibers undergo a pyrolysis.

12. The method of claim 10 or 11 utilizing a thermoplastic foam that contains polyurethane.

**13. The method of claim 12, wherein the carbon bonded precursor is mixed with fibers, water, organic binder and additives to control the rheology, prior to impregnating the foam.**

**14. A method to produce the ceramic filters according to anyone of claims 1 to 3 and 5 to 8, comprising the steps**

- a) pressing a semi-damp mixture comprising, fibers, ceramic powder and a graphitizable bonding precursor and optionally other additives in a hydraulic press,**
- b) pressing to obtain a perforated article in the shape of a disk or a block,**
- c) firing the perforated article in non-oxidizing and/or reducing atmosphere at a temperature in the range of from 500 °C to 1000 °C, in particular from 600 °C to 700 °C,**

**whereby the carbon bonding precursor is converted partially or fully to a bonded network of graphitized carbon.**

**15. A method for producing filters for molten metal filtration comprising fibers and a bonded network of graphitized carbon, comprising the steps**

- a) pressing a semi-damp mixture comprising, fibers and a graphitizable bonding precursor and optionally other additives in a hydraulic press,**
- b) pressing to obtain a perforated article in the shape of a disk or a block,**
- c) firing the perforated article in non-oxidizing and/or reducing atmosphere at a temperature in the range of from 500 °C to 1000 °C, in particular from 600 °C to 700 °C,**

**whereby the carbon bonding precursor is converted partially or fully to a bonded network of graphitized carbon.**

**16. The method of any one of claims 10 to 15 wherein high melting pitch (HMP) is used as the graphitizable carbon bonding precursor.**



**17.** The method of any one of claims **10** to **16** wherein a slurry or semi-damp mixture is used comprising:

fibers in the range of 0,1 to 20 parts by weight,

graphitizable carbon bonding precursor in the range of from 2 to 15 parts by weight,

ceramic powder in the range of from 0 to 95 parts by weight,

anti-oxidation material in the range of from 0 to 80 part by weight,

graphite in the range of from 0 to 90 parts by weight,

organic binder in the range of from 0 to 10, in particular 0.2 to 2 parts by weight and,

dispersion agent in the range of from 0 to 4, in particular 0.1 to 2 parts by weight.

**18.** The method of claim **17** wherein metallic powders such as steel, iron, bronze, silicon, magnesium, aluminium, boron, zirconium boride, calcium boride, titanium boride and the like, and/or glass frits containing 20 to 30 weight percent or boric oxide are used as the antioxidation material.

**19.** The method of claim **17** or **18** wherein a green binder such as PVA, starch, gums, sugar or the like or a combination thereof is used as the organic binder.

**20.** The method of any one of claims **17** to **19** wherein ligninsulphonate is used as the dispersion agent.

**21.** The method of any one of claims **17** to **20** wherein a slurry or semi-damp mixture is used that further comprises:

a plasticizer such as polyethylene glycol (molecular weight: 500 to 10000) in the range of from 0 to 2 parts by weight,

an anti-foam agent such as silicon anti-foam in the range of from 0 to 1 part by weight.